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EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

THIRTEENTH ANNUAL REPORT

1940

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REPORT OF DIRECTOR.

RESEARCH.

A statement of the policy governing the research programme of the Station in the past was published in the last annual report. During 1940 this policy has been in a state of flux. Early in the year, following proposals made by me in December, 1939, it was agreed by the East African Governments that the research programme should be modified so as to release as many of the staff as possible to assist other technical departments in East Africa and to concentrate the remainder on short-term research projects of immediate importance, at the same time carrying on those long-term investigations which could not be interrupted without sacrificing progress already made. In fact, the first of these proposals came to nothing and the staff continued to work at Amani at almost full strength until July.

Meanwhile the East African Directors of Agriculture in conference considered a memorandum on the co-ordination and centralization of long-term agricultural research in East Africa submitted by the Director of Agriculture, Uganda, as the result of the Statement of Policy (1940) by the Secretary of State. The conference while agreeing to the main proposals in this memorandum decided that pending the reconstruction of East African agricultural research on the lines suggested it would be desirable that the Amani research programme should be continued on its pre-war basis.

In July, however, instructions were received to release for military service all those who were supernumerary to essential care and maintenance of the Station. Before full effect was given to these instructions the East African Economic Council decided that the Station should remain intact in order to carry out scientific investigations arising out of the war and to continue certain lines of fundamental research as far as possible. The research programme was accordingly modified and special investigations initiated chiefly in connection with the local production and utilization of the following: *Cinchona* products, motor spirit, vitamin C concentrates, castor oil, vegetable dye stuffs, vegetable insecticides, glycerine, cotton wool, epsom salts, camphor, strychnine, *Hydnocarpus* oil and certain essential drugs. Progress with the above activities is the subject of special reports not quoted here. In addition compilations were prepared on a range of plant products of possible importance in war. Assistance was also given to the Government Analyst, Dar es Salaam, in the preparation of vegetable ghee for the army authorities.

The following is a summary of other investigations unconnected with the war.

Cassava.

One of the main investigations in the long-term research programme of the Station is directed towards the improvement of cassava—a major source of starch in the African's diet. The importance of this work in its relation to increased food production needs no emphasis. The research falls into two phases, the testing of all available varieties for disease resistance and breeding from the best of these with the object of incorporating their resistance in the new varieties. A large crossing programme is planned for 1941 based on the results of recent research, which can be summarised as follows. In trials at the Kizugu farm few of the 108 imported varieties have shown disease resistance comparable with that of local varieties. Of the cassava x cassava crosses, a few have shown resistance to one or both of the groups of viruses greater than any local variety. The Ceara x cassava hybrids show high field resistance to both groups, but most are susceptible to infection by grafting. All the *Manihot dichotoma* x cassava crosses but one resisted mosaic viruses both by grafting

and by field infection, while only a small proportion were susceptible to brown streak disease. Treatment of these hybrids with Colchicine to obtain more fertile polyploid forms was continued, but so far with only limited success.

Cinchona.

The Entomologist reported that serious damage was done to a young plantation of *Cinchona ledgeriana* at Amani by *Helopeltis bergrothi* and indicated how this pest might be controlled.

The projected selection work from the 100 ac. of young Cinchona at Kwamkoro has not yet begun, chiefly owing to the difficulty of carrying out micro-analyses with small bark samples.

Coffee.

Perhaps the most important and difficult problem confronting the coffee planter is to determine the maximum crop that his trees will bear without suffering from over-bearing—the main cause of die-back and biennial cropping. Thanks to the facilities kindly placed at our disposal by a private concern, Dr. Nutman was enabled to initiate an investigation into this complex carbohydrate problem. Leaves, crop and branches were counted on several hundred selected trees which were excavated at intervals and the leaves, crop, branches, stem and roots dried, tested for starch, weighed and set aside for subsequent anaylsis. Illness interrupted this investigation, which will be completed as soon as possible.

Of the interspecific coffee crosses referred to by the Geneticist in his 1939 report 62 hybrids were obtained for the cross *Coffea canephora* x *C. excelsa* and two from the cross *C. eugenioides* x *C. excelsa.* A satisfactory number of plants were reared from the selfings of plants selected from amongst inbred F1 generations of *C. arabica* with the object of studying variability in factors concerned with yield (variation) in successively inbred families.

Some Colchicine treated coffee seedlings exhibited chromosomes doubling in the root-tip, but it is not certain that the aerial parts have been affected.

The Entomologist, up to the time of rejoining the R.A.F. in November, continued his studies of coffee leaf-miners, part of his general investigation into the ecology of coffee plantations. These leaf-miner studies remain disappointing and little further progress was made, mainly because both species (*Leucoptera coffeella* and *L. caffeina*) almost entirely disappeared from the Amani district, where they were previously a pest.

Fibre Crops.

Agaves. The Geneticist maintained close contact with the Sisal Experimental Station, Mlingano, and continued breeding and selection in co-operation with the officer in charge. A first consignment of hybrid seed was sent to the new High Level Sisal Experimental Station in Kenya. The most promising hybrids bred so far are from *Agave angustifolia* x *A. amaniensis,* the majority being extremely vigorous with high leaf number and good leaf length. The *Agave amaniensis* x *A. sisalana* hybrids do not compare favourably with the above There is nothing further to report on the comparative trial of *Agave amaniensis* (Blue Sisal) and common sisal, except that the inability of the former to maintain uninterrupted growth under estate conditions is a serious disadvantage.

An introduced tetraploid *Agave* species flowered for the first time and was crossed with other species and selfed. Other crosses made include those between seedlings of *A. angustifolia* selected for high leaf number. Cytological studies of *Agave* species and hybrids continued.

The Soil Chemist spent some months investigating a case of increasing soil salinity on a sisal estate situated on the alluvial apron below a high escarpment. The problem at first appeared to be local but later was found to be of wider interest and almost certainly due to a recent rise in the dry-season

level of the ground waters following the felling of woody vegetation from the base of the escarpment above, thus reducing the amount of water removed from the soil by transpiration.

Maize.

Streak disease is an important factor governing maize production in parts of East Africa. The lengthy studies of this disease carried out at Amani have now been turned to the breeding of maize for resistance. During 1940 the resistant Barberton types were crossed *inter se* and outcrossed to certain East African maize types. Trials of the progeny by controlled insect infection are now in progress.

Native Food Crops, Improvement of (other than cassava and maize, q.v.).

Early in the year the Directors of Agriculture of the East African territories agreed to the adoption of a proposed general policy drafted by me for the improvement of native food crops by breeding, selection and introduction. It has not been thought possible to draw up a programme based on this policy in present circumstances. The establishment of a comprehensive collection of food-crop varieties at Amani, particularly pulses and root crops, has been well justified judging by the numerous applications for planting material. Expansion in this direction is handicapped by lack of suitable land at or near Amani.

Investigations on the resistance of sorghum varieties to witch weed or *Striga,* a serious pest in parts of East Africa, were continued. The evidence so far accumulated by the Geneticist indicates that varieties resistant to *Striga asiatica* are not necessarily resistant to *S. hermonthica.* A test of 16 single plant progenies of Bonghonilo, which resists *S. asiatica,* is proceeding.

Passiflora.

The variety collection has been maintained for study and as a source of breeding material if needed. The investigations into the woodiness disease of passion fruit is now in the hands of the Agricultural Department, Kenya.

Tung (*Aleurites montana*).

Seedlings of the highest yielding plants in the young plantations have been established in a yield trial. Similar selections will be made from the 100 acres of *A. montana* at Kwamkoro.

Vegetable Insecticides (*Derris, etc.*).

The Biochemist had little opportunity for continuing fundamental studies of insecticidal plants; he showed, however, that the production of rotenoids in seedlings of a *Millettia* sp. is unconnected with photosynthesis.

The Geneticist carried out cytological studies on derris and attempted to produce hybrids between several species.

As the result of preliminary trials which showed no advantage from applying manure to derris (except phosphates) a comprehensive manurial trial was laid down. Trials were also established to study spacing, effects of hormones and continuous cropping on derris.

Ornithology.

Grants made by the Royal Society of London and the British Museum (Nat. Hist.) enabled Mr. Moreau to pursue his studies and to send collectors to the Kungwe Peninsula of Lake Tanganyika, with most interesting results. Several papers were prepared for publication by Mr. Moreau during the year.

Soil Science.

The Soil Chemist and the Botanist attended an interterritorial pasture conference at Nairobi in August when the former submitted a paper on soil survey as an element in pasture research. The Kenya Government endorsed the proposal to conduct vegetation and soil survey as a preparation for a comprehensive pasture research programme in East Africa. At the request

of the conference a committee, including these two officers, is drawing up a classification of East African vegetation types as related to pasture.

At a meeting held at Amani in April of officers concerned with the projected nutrition survey (later abandoned) in the Tanga Province a memorandum was submitted by Mr. Milne outlining the important part that could be played by soil investigations in nutrition surveys. Other activities of the Soil Chemist, who devoted much of his time to special wartime activities connected with *Cinchona* products, are reported upon above under sisal.

Systematic Botany.

The existence of a herbarium and a systematic botanist at Amani has been of particular value of late in connection with numerous requests for botanical information on subjects related to the war. The botanist amongst other activities prepared valuable compilations on medicinal plants, wild spinach plants suitable for troops in the field and the gums and resins of East Africa.

ADMINISTRATION.

Dr. Storey was in charge of the Station during my absence on special leave from May to November, an anxious period when but for his representations the Station might have been closed for research. The following officers are serving with the forces: Messrs. Kirkpatrick, Nichols, Calton and Gibbins. Mr. Nutter was seconded to the Information Office throughout the year. Mr. Stent, of the Department of Agriculture, Tanganyika Territory, was seconded to the Station from November.

Amani Plantations.

Lack of arable land and the low fertility of almost all the developed areas continues to be a handicap to that part of our work which depends on field experiments. The increasing toll taken by the tsetse-fly during the year aggravated the problem by decreasing manure supplies.

Re-development of Kwamkoro Estate (C.D.F.).

As in 1939, derris, quinine and tung showed most promise and coffee the least. Derris is undoubtedly well suited to local conditions and, given the demand, should prove a profitable crop. The economics of *Cinchona* and tung cannot be judged until these crops mature. Coffee, except for the well-manured robusta area, is a failure.

The increase in trypanosomiasis amongst the cattle is a matter for concern.

East African Central Quarantine Station.

Importations consisted chiefly of cassava, derris and Manila hemp.

East African Agricultural Journal.

The Journal, which is edited from Amani, was reduced to a quarterly during the year, chiefly as an economy measure, with a consequent reduction of a third in the bulk of each volume. Material submitted for publication has on the whole been of high quality with noteworthy contributions from forestry and medical departments, in addition to agricultural and veterinary.

The Amani Library.

The reorientation of the Station's work produced unexpected demands on the library. An increasing number of scientific workers in East Africa made full use of the Librarian's offer to abstract references to their particular subjects appearing in incoming literature.

The generous assistance given by the Belgian Congo authorities at Leopoldville was much appreciated.

Finally, I wish to record my appreciation of the loyal co-operation of my staff and the assistance given me by the East African Directors of Agriculture during a difficult year.

A. GLENDON HILL,
Director.

March, 1941.

PLANT PATHOLOGY.

I was Acting Director of the Station during a critical period from May to November. Mr. Nichols, my assistant, left for military service in August. Nevertheless the work of the section has continued, if inevitably at a reduced rate. In accordance with the policy outlined in my report for 1939, work has been mainly concentrated on the breeding of cassava and maize for disease resistance.

Cassava.

The attempt to obtain cassava varieties resistant to the two groups of viruses, mosaic and brown streak, have continued on lines described in earlier reports. Some of the evidence now available is encouraging; but it is too early to say whether the object will be achieved.

The work falls into two phases: the testing of material for resistance to viruses; and the breeding of new types by crossing parents having the desired characters. Naturally, the second must await the results of the first, if it is to be done to the best advantage.

Field testing now takes place in two stages; a preliminary unreplicated trial serves to eliminate the more susceptible clones and so reduce to manageable numbers those that pass to the second stage, the fully replicated trial. During 1940 two large-scale trials, each of 100 clones in a triple lattice design, have been completed. At the end of the year two further trials, on a changed design, including 96 clones, were planted.

Crossing during early years was carried out inevitably with parents selected on very limited knowledge of their capabilities. The results of the three large trials now completed at Kizugu provide some foundation for the selection of parents for future breeding. A large programme of crossing is in hand at the time of writing this report.

Results up to the present may be briefly summarised as follows. Very few of the 108 varieties imported from overseas exhibit resistance comparable with that of local varieties and the majority have been discarded. Of the cassava x cassava crosses, a few appear, on the basis of a single trial, to be more resistant to one or both of the groups of viruses than any local variety. The Ceara (*Manihot glaziovii*) x cassava hybrids have shown high field resistance to both viruses, although most are fully susceptible to infection by grafting. All the *M. dichotoma* x cassava crosses but one have resisted the mosiac virus both by grafting and by field infection; and only a small proportion are susceptible to brown streak.

An open pollinated F2 generation from the Ceara hybrids has been raised and is now under test. Controlled F2 crosses of selected clones have been carried out in 1940 and are now in hand.

The *M. dichotoma* hybrids have proved to be not entirely sterile, as previously reported. Cytological studies by the Geneticist of the 1939 series of colchicine treated plants have shown that 9 out of 61 contain some tetraploid tissue. These 9 plants have not exhibited any markedly enhanced fertility; from the whole series 25 seeds were obtained during the year, of which 7 were successfully germinated. The resulting plants are all dwarfed or have malformed leaves; cytologically four are diploids, one a triploid and two are not yet examined.

Treatment with colchicine was repeated during the year in a considerable series of experiments, employing a number of new methods of application. In the early stages of growth the effect of treatment was very marked; stems were enlarged and leaves thickened. Later however the plants grew out apparently normally. They have not yet been examined cytologically.

Further experiments with the suspected vector of the brown streak virus mentioned in my 1939 report gave so small a proportion of infections that the identity of the vector cannot yet be regarded as confirmed. It seems likely that transmission occurs only under certain restricted conditions that are not yet understood and have not been satisfactorily reproduced experimentally.

Maize.

An extensive collection was received from the Director of the Cotton Experiment Station, Barberton, of the inbred lines of Peruvian Yellow Flint selected for resistance to streak disease. During the year these lines were successfully grown at Amani, selfed, crossed *inter se* and outcrossed to certain East African types of maize. Trials of the progeny by controlled insect-infection are now in progress. At this stage nothing can be reported on these trials, except that the claims for the resistance of the Peruvian lines have been confirmed.

Special War-time Work.

Preliminary enquiries have been set in train concerning the possibility of local production of Ergot for medicinal use.

H. H. STOREY,

Plant Pathologist.

ENTOMOLOGY.

(January—July, 1940.)

Little further work has been done on the leaf-miners (*Leucoptera* spp.) attacking coffee, mainly because both species (*L. coffeella* Guér. and *L. caffeina* Washbn.) have almost entirely disappeared from the Amani district. This disappearance seems to be chiefly due to a reduction in the egg-laying capacity of the moths; the few that could be obtained laid a very small number of eggs (often none at all) although they were kept under exactly the same conditions as those which, two years ago, laid on the average some 75 each.

It had been intended to attempt the introduction of the most important parasite of *Leucoptera* at Amani (*Eulophus* sp.) to Lyamungu, in which district it does not occur. Owing, however, to the difficulty of breeding the host, because of its infertility, very few could be obtained, and by the time some were available the Entomologist at Lyamungu had been released for military service.

Some preliminary work has been done on *Helopeltis bergrothi* Reut. (vars. *rubrinervis* Popp. and *disciger* Popp.) on *Cinchona*.

This is a pest of which very small numbers cause a large amount of damage, resulting in serious set-back to young plants.

Two parasites of *Helopeltis* have been discovered though one of them is almost certainly a hyperparasite. It is believed that *Helopeltis* can be easily controlled by a sweetened sodium arsenite bait (about 1 oz. sodium arsenite with 5 lbs. sugar in 4 gallons water). This gave excellent results in a small laboratory test, but there has not yet been an opportunity to try it in the field. A short paper on this work has been written.

T. W. KIRKPATRICK,

Entomologist.

SOIL SCIENCE.

Effective work on soil subjects has been possible only during six months of the year, between my return at the end of February from a temporary posting as an Agricultural Officer, and my being detailed for other chemical work,

chiefly connected with cinchona products, at the end of August. Mr. Calton, Scientific Assistant, after a delayed return from European leave in January, joined H.M. Forces at the end of July.

Vegetation, ground-water and soil salinity.

About three months were devoted to investigating certain occurrences of soil salinity on a group of sisal estates. Sisal that had yielded several cuts of normally-developed leaf had begun to die in spreading patches, the affected fields being strung out along the foot of an alluvial apron at a little distance from the base of a high escarpment. In two considerable areas about five miles apart the soil surface had become quite bare except for a salt-tolerant shrub *Suaeda monoica* Forsk.; at intervening places the sisal had become stunted and sickly or was already dead, and the soil showed saline efflorescences locally. By inspection of test pits and analysis of a large number of soil samples it was established that salt concentrations were present at or near the soil surface, up to six per cent. of mixed chlorides and sulphates being recorded in the top 10 cm. at the worst places, and that the salts were ascending from a water table at varying but not great depth below ground. The immediate reason for the appearance of high salinity within the root range of sisal that clearly had had no such adverse factor affecting its first years of growth, was judged to be a recent rise in the dry-season level of the ground waters, and the problem resolved itself into a study of the possible causes of this disturbance of a formerly more favourable ground-water equilibrium. After consideration of the topography and, as far as was possible without more detailed survey, the hydrology of the escarpment-foot strip, together with the history of the occupation of these lands during the last thirty years, it was concluded that the disturbance was an effect of recent clearings of woody vegetation from the slopes at the base of the escarpment, above the affected fields. The total of water consumed in transpiration by trees and bush had thereby, it was thought, been much reduced, so leaving an excess to percolate through the subsoil of the alluvial fans and accumulate in sluggishly-drained sumps in the subsoil of the edges of the plain. It has since been learned that close parallels to this effect are known from the history of land settlement in parts of Australia.

In the particular circumstances of this escarpment-foot region, it seems as though the whole of the cultivable land cannot be brought successfully at any one time under field crops. *Either* a proportion of the higher-lying lands is left under the cover of a more heavily water-consuming vegetation, in order that the water table may be prevented from rising under the lands at the edge of the plain; *or* the latter are resigned to an increasing salinity as their water table rises, for the sake of a fuller utilisation of the better-drained red earths of the fan-slopes above. An escape from this dilemma would be possible if the sump sites could be kept drained by artificial means, but the levels and minor relief of the plain, the conformation of the conjoined alluvial fans that bound it on the escarpment side, and the behaviour of the near-by river at times of flood, together with the low value per acre of the produce of the lands in question under sisal, combine to make the chances of reaching an economic solution remote. The problem was finally reported on in this sense, but attention was drawn to its regional (rather than local) nature, as affecting either presently or potentially the land utilisation pattern of a considerable strip of country situated along the foot of these highlands and including public lands in native occupation as well as sisal estates. It is a case where the investigation of a local infertility, thought at first to be purely an affair of the estates affected, has led by the adoption of a broad basis of enquiry to the recognition of effects of much more general interest.

The Agricultural Officer (Sisal) of the Tanganyika Department of Agriculture (Mr. G. W. Lock) collaborated in this investigation. The report, which

included details of the soil complex concerned and an account of the general geography of the area, was given a limited circulation through the Department of Agriculture.

Soil Survey.

The case just described is an example of a rather localised enquiry which would be the better for extension by soil survey over the larger area where somewhat similar circumstances obtain. A recommendation for a soil and land utilisation survey of the escarpment-foot region as a whole was included in my report. A similar but more comprehensive recommendation covering the same region was made independently in Report No. 3 of 1939 of the Water Consultant, Tanganyika (" Preliminary Remarks on the Pangani Drainage "), which was not available to me at the time. Nothing is likely to come of these recommendations in present circumstances, but it is well that the fact that they have been made should go on record.

In April, during a conference at Amani of the officers detailed by the Tanganyika Government to conduct a Nutrition Survey in Usambara, arrangements were made in outline for my co-operation in this project by soil survey and other soils work. Memoranda outlining the part that could be played by soil investigations in Nutrition Surveys were prepared at that time and are on record, but in June the intended Survey was postponed indefinitely.

In April also, after the Secretary of State's announcements of February in regard to developments in Colonial policy, a paper (" Soil Survey in East Africa: Some Needed Developments ") was prepared in support of a request for increased provision for soil research, in particular the setting up of one or more field units for soil survey. Like other proposals of its kind this has now to await better times.

In August I attended with the Botanist an inter-territorial Conference on Pasture Research held in Nairobi and submitted a paper " Soil Survey as an Element in Pasture Research ", the argument of which was accepted by the Conference and on its recommendation was subsequently agreed to in principle by the Kenya Government. Vegetation and soil surveys were agreed to be a desirable first stage in the scheme of Pasture Research proposed by the Conference. I undertook the chairmanship of a committee on the classification of East African vegetation types for the purposes of pasture research. Some progress has been made with this committee's work.

Mr. Calton overtook some arrears of analyses upon soil reconnaissance material from previous years, and began an investigation of clay fractions by the method of dye absorption; but this work ceased in July. In January he had carried out a preliminary survey of land that was under consideration for a low-level sub-station for Amani, and in March I continued this in other adjacent areas, but in the event the project was not proceeded with. In April I reported with the Agricultural Officer, Tanga District, on the situation as regards sheet erosion on the steeply-sloping lands of a native area on Mlinga, a high outlier of East Usambara.

Soil Exhibit, Dar es Salaam Museum.

A permanent exhibit of twenty-four soil profiles of Tanganyika was prepared in July for the King George V Memorial Museum in Dar es Salaam, which was opened later in the year.

Publications.

The Report on my visit of 1938 to parts of the West Indies and the United States was published by the Government Printer, Dar es Salaam, in June,

and circulated. Several chapters of this report appeared as articles in the East African Agricultural Journal, also a shorter note and a review on pasture subjects.

G. MILNE,
Soil Chemist.

BIOCHEMISTRY.

I returned from vacation leave at the beginning of the year and spent a week at Dar es Salaam discussing with the Government Analyst war-time investigations which I might be called on to undertake. On my return I carried on with my normal work for a short time, but since June I have concentrated almost entirely on special war-time investigations.

In consequence I have little to report in connection with my fundamental work on vegetable insecticides. I have shown, however, that the production of new rotenoids in seedlings of one species, at least, of *Millettia* is not connected with photosynthesis since the production still occurs in the complete absence of carbon dioxide. Histological examination has been extended to more species and amplified with others.

The derris plot experiment to determine the effect of age and staking on yield and rotenone content is in process of harvesting at predetermined intervals, and the experiment to determine any effect of season of harvesting is now due for digging.

All preliminary work on manuring derris has indicated either no change or a depressing effect on yield, except with phosphates, and a comprehensive manurial plot experiment has therefore been laid out.

Two other plot experiments have been started this year, one to study the effect of spacing on yield and the other the effect of treating the original cuttings with hormone solution. The effect of replanting derris in old ground immediately after digging is also under investigation.

War Problems.

Glycerine.

I have investigated the question of glycerine production from the spent lyes from soap manufacture. Through the kindness and co-operation of the Noorani Industrial Co., Ltd., who have an up to date works in Tanga, I was able to follow up my laboratory scale work with semi-commercial scale trials.

Only coconut oil is used in soap-making in East Africa, and the process differs from nearly all others in that the soap cannot be salted out with common salt and in consequence there is seldom any glycerine-containing lye left over. It can be salted out by having at least 20 per cent. caustic soda in the lye but this would require the importation of large quantities of sulphuric acid to neutralize it. I worked out a process to avoid this by using the spent lye for a second soap-making and then neutralizing the excess of soda with another oil, such as cotton seed or kapok, which produced a soap capable of being salted out with common salt. A lye with a good concentration of glycerine resulted and crude glycerine was readily obtained from it.

Orange juice concentrates.

I investigated the possibility of producing a vitamin-active concentrate from the large number of bitter oranges available at Sigi Segoma. The fresh juice contained 35 to 45 mg. ascorbic acid per 100 c.c., and concentrations up to 250 mg. per 100 c.c. were readily obtained by evaporation under vacuum. The concentrate was very bitter and more palatable concentrates were obtained

by partly neutralizing the juice with sodium carbonate, without loss of ascorbic acid. Mr. Glover who helped me with the initial part of this work later took over the whole investigation.

Strychnine.

I began the examination of local *Strychnos* species as a source of strychnine. Of five species examined only one probably contained strychnine, and that only in minute amounts.

Ghee substitutes.

At the request of the Tanganyika Medical Department I supervised the production, at the Noorani works in Tanga, of three large samples of substitute ghees made from vegetable oils. Two have since been reported as satisfactory.

Petrol from vegetable oils, etc.

Preliminary work is in progress to decide if it is possible to prepare petrol from vegetable oils or the fatty acids obtained from them, as there are large stocks of these products now in East Africa. Distinctly hopeful results have been obtained.

R. R. WORSLEY,

Biochemist.

PLANT PHYSIOLOGY.

During the early part of the year I was engaged in the calibration of the apparatus for the measurement of low concentrations of carbon dioxide by infra-red radiation. Although certain experimental difficulties have yet to be overcome, the value of the method is becoming apparent. Professor Dingle, with whom I worked on the design of the apparatus, has recently published a description of it (*Proc. Roy. Soc.* B. 1940).

Later, during a period of local leave spent near Arusha, I was impressed by the unusually favourable conditions for an attempt to solve what is perhaps the most important practical problem confronting the coffee planter, namely, that of determining the maximum crop that will ensure that the trees remain undamaged by overbearing. Since this problem is intimately connected with our research at Amani, other work was postponed, and field work started in early April. Leaves, crop, and branches have been counted on several hundred selected trees; they have been excavated at intervals, and leaves, crop, branches, stem, and roots have been dried, tested for starch, weighed, and preserved for analysis. Illness has interrupted this work, but through the enthusiasm of the manager of the estate on which it was being carried out the sampling has been completed by them. The whole series of samples now awaits analysis.

I went on special leave to South Africa in August, returning in mid-December. Since then I have been employed in *ad hoc* research on war-time problems.

Mr. Glover, during his absence on leave, from February to September, met Dr. Tincker, Dr. Metcalfe, and Professor Stoughton, and discussed with them the suggestion that some abnormality in the hormonal balance of the clove tree might be responsible for the Sudden Death disease. They considered such an hypothesis unlikely, and inclined to ascribe the disease to some interference with normal nutrition. Mr. Glover also took a course in glass-blowing at Belfast.

Since his return to Amani Mr. Glover, in collaboration with Dr. Worsley, has prepared concentrates of high ascorbic acid content, from local bitter

orange juice, with a view to their utllization as anti-scorbutics for troops in the field. He has also investigated the possibilities of preparing medicinal castor oil from the large supplies of castor seed available in East Africa.

The following papers have been published during the year:—

Nutman, F. J. Studies in the Physiology of *Coffea arabica* III. Transpiration rate of whole trees in relation to natural environmental conditions.

Schmid, F. A. F., and Nutman, F. J. A convenient method for the excavation of growing trees in undisturbed soil.

Glover, J. A method for the continuous measurement of transpiration of single leaves under natural conditions.

F. J. NUTMAN,
Physiologist.

PLANT GENETICS.

General.

I have been away from the station for three short periods visiting (1) the Sisal Experimental Station, Ngomeni, for cytological work on *Agave* hybrids, (2) the High Level Sisal Station, Thika, Kenya and (3) cinchona plantations in the East and West Usambaras. Whilst in Kenya I paid a flying visit to the Karimani coffee station with Mr. S. Gillett, of the Coffee team, and to the Scott Agricultural Laboratories to see recent developments in coffee investigation. On the return journey to Amani I visited the Coffee Research Station at Lyamungu, Moshi.

Agaves.

1. Material growing at Amani:—

There is nothing further to report on the comparative trial of *A. amaniensis* V. *A. sisalana*. *A. amaniensis* has stopped growing and has consequently not been cut during the year. The inability of *A. amaniensis* to maintain uninterrupted growth under cultivation and cutting is a serious disadvantage. It is also more susceptible to weevil attack and boll rot than *A. sisalana*.

An undescribed tetraploid species received from La Mortola, Italy, as *A. nirvana* has flowered and, as this shows some promise as a fibre producer, it has been selfed and crossed with several other species. Other breeding work with *Agave* includes crosses between seedlings of *A. angustifolia* selected for a high total leaf production. One of these has also been crossed with *A. amaniensis* and part of the seed sent to Kenya for trial.

2. Material at the Sisal Experimental Station, Ngomeni:—

The most promising hybrid material raised is from *A. angustifolia* x *A. amaniensis*. Three plants poled early in the year and were successfully selfed and also pollinated with pollen of *A. amaniensis* by the Agricultural Officer in charge, Mr. G. W. Lock. Many more are poling now (December, 1940) and further breeding work is contemplated.

The development of these hybrids has been very vigorous for the most part but a proportion show the *A. amaniensis* characteristic of cessation of growth: The intention was to leave this first generation to develop normally, without cutting, in order to hasten poling and further breeding work, but it has become necessary to cut them in order to gain access for selection of the most promising material. Mr. Lock and I have made tentative selections both for further breeding work and for comparative trials with *A. sisalana* when bulbils are available.

A. amaniensis x *A. sisalana* hybrids are not of any great interest. Plants that have flowered have all proved sterile and are therefore useless for any

further breeding work. They do not compare favourably, from the point of view of productivity, with the *A. angustifolia* x *A. amaniensis* hybrids.

Hybrid families planted in the field this year include *A. amaniensis* x *A. lespinassei* and *A. angustifolia* x *A. lespinassei*. The first contains plants with smooth and with spiny leaf margins, the second is entirely spiny margined. *A. lespinassei* should introduce into the crosses the characters for many and also long leaves.

3. Cytology:—

Cytological studies have been made on flower bud material of the hybrids at Ngomeni and species flowering at Amani. Chromosome counts in root tips of other species now established at Amani are being continued.

Coffee.

Interspecific crosses mentioned in the last annual report (p. 17) were not very successful. Only two seedlings have been raised from the cross *C. eugenioides* x *C. excelsa* and 62 from the cross *C. canephora* x *C. excelsa* The other crosses failed.

A satisfactory number of plants have been raised after selfing plants selected from amongst inbred F1 generations of *C. arabica*.

Coffee material treated with colchicine has nearly all been planted in the field, as it was uncertain whether, owing to a change of policy occasioned by the war, there would be an opportunity for carrying on the cytological side of the investigations. A few plants were too small to be put out and root tips of these have since been examined. Two of these, *C. canephora* (germinating seeds treated), give a count of $2n = 4x = 44$ chromosomes in the root tips, but it is not yet certain that the aerial parts of the plant have also been affected.

Striga.

Investigations on the resistance of sorghum varieties to attack by *Striga hermonthica* have been continued. The evidence so far accumulated indicates that varieties resistant to attack by *S. asiatica* are not necessarily resistant to *S. hermonthica*. Four such varieties tested so far have succumbed completely to attack by the latter species. A test of 16 single plant progenies of the variety Bonghonilo, supplied by the Acting Agricultural Officer, Lubaga, Shinyanga, is proceeding. This variety is reported as being found resistant to *S. asiatica* in India.

Aleurites montana.

Nine of the highest yielding plants in the young plantations have been selected for a trial of their progeny against that of the original two parental plants. This trial was planted in September, 1940, and in spite of the lack of rain the plants are growing strongly.

Cinchona.

A survey of existing plantations was carried out to provide estimates of the amount of bark of the different species that is likely to come on the market in the next three years. As a result of this survey a memorandum was prepared indicating certain lines of agronomic investigations urgently required if the industry is to be assisted to develop on sound economic lines.

Cassava.

I have continued cytological work on this crop in co-operation with the Plant Pathologist. Examination of the first series of hybrids treated with colchicine shows that only a very small proportion of plants have been affected by the treatment and these are probably chimaeras having a portion only of tetraploid tissue.

Derris.

Amongst the Biochemist's collection of *Derris* spp. several flowered this year and at his request I endeavoured to make some varietal and some interspecific crosses. None were successful, as all the flower abscissed at the base of the pedicel. Chromosome counts were made in root tips of two clones, both supposed to be *D. elliptica*. One gives a high root yield of fairly low rotenone content and the other has a moderate yield of root of high rotenone content. The first was found to have 22 chromosomes and the second 20. According to Heyn (Ann. J. Bot. Buitenzorg 1938: 48: p. 103), *D. malaccensis* has 22 chromosomes and *D. elliptica* 20. It is therefore probable that these two clones belong to the two different species. I have not yet examined authentic material of *D. malaccensis* for a comparison. The 22 chromosome form produced a high proportion of abortive pollen: that of the 20 chromosome form had abundant, good pollen.

L. R. DOUGHTY,
Geneticist.

SYSTEMATIC BOTANY.

A special feature of my work during the year has been the supply of information on problems of economic botany connected with the war.

Routine herbarium work continued. Over 2,700 specimens have been determined from collections made by Tsetse Research, Medical and Agricultural Officers in Tanganyika, Kenya and Nyasaland, as well as much material from the Coryndon Memorial Museum, Nairobi.

Fifty-six consignments of unnamed botanical material, comprising over 1,800 plants, were received for identification, the majority from Kenya and Tanganyika. An interesting collection was received from Mr. A. P. Forbes, Agricultural Officer, Nyasaland, who had started a botanical survey of Mt. Mlanje. This collection was a very welcome addition to the Amani Herbarium as the flora of Nyasaland is not represented here. Mr. C. G. Hansford, Senior Plant Pathologist, Department of Agriculture, Uganda, sent further named specimens of leaf-fungi.

Over 1,200 named specimens have been distributed, the bulk to the Royal Botanic Gardens, Kew. There are still many named duplicates for disposal to other botanical institutions whenever the times return to normal.

A further nine unrecorded type specimens were discovered in the Herbarium and two new species including a new grass genus from Amani have been described at Kew; these bring the total of recorded types in the Herbarium to 374.

Over 1,600 named specimens have been laid into the Herbarium, bringing the total available for study at Amani to 40,300, compared with 10,000 in 1928. The floras of Tanganyika and Uganda are fairly well represented, Zanzibar and Pemba more or less, mostly by my own collections, Kenya, Northern Rhodesia, and Nyasaland hardly at all. Although so imperfect the Amani Herbarium has been of great value in connexion with questions arising out of the East African war effort, and with the card index of native names and native uses of plants which I have been building up it has proved its worth. Plans for a new herbarium to house the rapidly expanding botanical collection, unfortunately had to be abandoned on the outbreak of the war.

I attended a Pasture Research Conference in Nairobi in July when the opportunity was taken to visit with the other delegates the Kamba Reserve to see the erosion there due to overstocking and bad methods of agriculture. I also named some of the plants in the *Passiflora* collection at the Scott

Agricultural Laboratories. The botanical collections were studied at the Coryndon Memorial Museum where the Botanist in charge is entirely dependant on Amani and Kew for the determinations of the Museum material.

In addition to my normal duties I have acted as honorary forest officer and, jointly with the Geneticist, as a meteorological observer for the British East African Meteorological Service.

During the early part of the year I continued work on a List of Trees and Shrubs of Tanganyika Territory, under the editorship of Dr. Burtt Davy for the Imperial Forestry Institute. As a result of his death, the project has been given up for the time being.

During the year the revised edition of my Swahili-Botanical-English Dictionary of Plant Names appeared and I also contributed reviews to the East African Agricultural Journal.

P. J. GREENWAY,
Systematic Botanist.

ORNITHOLOGY.

During the year research grants have been made to me by the Royal Society of London and the British Museum (Natural History).

The Royal Society grant has enabled the study of nesting-behaviour rhythms to be pursued (by means of African observers). There have been specially favourable opportunities for the observation of Palm-swifts (*Cypsiurus parvus*) and the peculiar breeding biology has been fairly well worked out. It is noteworthy that the newly hatched birds, though blind and naked, have unusually well-developed claws and have to support themselves on the vertical nest pad by their own efforts. A preliminary paper, based on the first 700 hours of observations, has been prepared for publication.

The British Museum grant was for the purpose of sending collectors to the Kungwe Peninsular, on the east shore of Lake Tanganyika, south of Kigoma, in an area that is little explored biologically. The results are of even greater interest than had been expected. Preliminary work on the specimens indicates that there are two or three new species and a number of new subspecies. The affinities are much stronger with Uganda than with the north end of Lake Nyasa. In the present circumstances it is necessary for as much of the taxonomic work as possible to be done locally; and in this connection I must thank Dr. V. G. L. Van Someren for generous help.

In the latter half of the year there has been an interesting abnormality in the breeding activities of some species at Amani. This may be connected with the abnormal weather (see Appendix B) but such an effect would hardly have been expected in an evergreen environment. The records accumulated over a number of years are being collated for critical review.

In the course of the past work several hundred native names have been recorded, identifications verified and interpretations sought. The results show that the local Africans have named their birds ingeniously and often on the basis of a good field knowledge. A list has been prepared for publication.

The collation of data on clutch-size in relation to latitude has continued.

During the year papers have been published on the avifauna of the East African islands, the behaviour-rhythms of the Bank-martin (*Psalidoprocne holomelaena*), new records for Tanganyika, the incubation and fledging periods of African birds and the biology of hornbills. Publication of the study of the land-vertebrates of the East African islands has been delayed, and meanwhile the main conclusions have been printed in *Nature*.

Birds described from collections sent to the British Museum since the last mention of new forms in my reports are:—*Cyanomitra olivacea puguensis* Van Someren, the highly peculiar *Artisornis winifredae* Kinnear, *Illadopsis rufipennis puguensis* Grant & M. Praed and *Sheppardia cyornithopsis usambarae* Macdonald.

R. E. MOREAU.

PLANTATION WORK.

The Assistant Superintendent left Amani in July for military service.

Work on native food crops continued and greater interest by planters was very noticeable, quantities of planting material being supplied to several estates in the Tanga district.

The production of red palm-oil for issue to labourers continued, and although unavoidably suspended from September onwards 1,725 lbs. of oil was produced.

The maintenance of all crops under the Kwamkoro development scheme continued. Manurial and spacing trial plots of derris were also planted on the estate in connection with the Biochemist's investigations.

Amani Plantations and Nurseries.

Derris elliptica.—Grafts mentioned in the last report continue to grow well. A few plants of *D. elliptica* flowered for the first time but were sterile. Work continued on the experimental " staked " and " unstaked " plots for the Biochemist's investigations.

Cinchona.—A small plot of *C. josephiana* was planted from seed obtained from Uganda. Seedlings have also been raised from imported Indian seed of highly-yielding trees. Experimental grafting of *Cinchona* species continued. One hundred *C. Ledgeriana* on *C. succirubra* stocks, 70 *C. Ledgeriana* on *C.* hybrid, 9 *C.* hybrid on *C. Ledgeriana* and 6 *C. josephiana* on *C. succirubra*. Over 100 oz. of *Cinchona* seed was distributed during the year.

The bark harvested in 1939 has realised £314.

Agaves.—A large number of seedlings have been raised and planted in nursery beds for the Geneticist. Eighty-five thousand blue sisal bulbils were distributed.

Hydnocarpus wightiana.—As a result of the renewed demand for chaulmugra oil the fruits at both Amani and the Kiwanda U.M.C.A. plantations have been collected. A further 500 plants have been raised in bamboo pots for extending plots at Kiwanda.

Aleurites montana.—An experimental plot of 150 trees has been planted from selected seed for the Geneticist. Eight lbs. of seed of this species was distributed.

Aleurites Fordii.—No work was done on this during the year. The existing trees again fruited and 3 lbs. of seed was distributed.

Tephrosia spp.—Plots of the available *Tephrosia* spp. have been extended for the Biochemist.

Sugar cane.—No varieties were introduced through quarantine during the year. One thousand and forty cuttings were distributed from previous importations.

Manila Hemp.—Three varieties of *Musa textilis* were introduced for the Uganda Agricultural Department. Two hundred suckers and 500 seedling plants from the Amani plots were distributed.

Cloves (*Eugenia caryophyllata*).—The grafted plants of *Psidium guava* and *Eugenia jambos* stocks mentioned in the last report were sent to the Zanzibar

Agricultural Department for trial there. No report on their success has yet been received but at the request of this department further stocks of *guava* have been grown for continuing this experiment.

Calophyllum Inophyllum.—Four thousand plants have been raised for the reafforestation programme planned to assure future fuel supplies and building poles. Over 1,000 Eucalyptus plants were planted during the year for the same purpose.

Native Food Crops.

Multiplication of native food crops continued, sorghums, grams, groundnuts, sweet potatoes, yams and maize doing exceptionally well. Soya beans were not so prolific as in the previous year. Distribution of planting material greatly increased. In addition to quantities of sweet potato cuttings and yam tubers 54 lbs. and 668 packets of seeds were distributed.

Quarantine.

Importations through quarantine were limited to small quantities of cassava, derris, Manila hemp and two miscellaneous collections.

Kwamkoro Estate.

Derris.—Two and a half tons of dry root was harvested and sent to London, 27,000 cuttings were distributed and 25,000 plants planted out during the year. A larger area is being prepared for early planting in 1941. Derris plots planted in 1938 and 1939 continue to do well.

Experiments now show that staking the plants increases the root yield and derris plots are now staked as soon as the young plants have established themselves.

Arabica Coffee.—The grafted arabica on robusta stocks is still little different from arabica growing on its own root systems. The plot which has been extensively cultivated and manured shows little prospect of becoming an economic success.

No work was done on the old arabica plantations except to collect the small crop, ½ ton of parchment.

Robusta Coffee.—The intensive culture plot of 10 acres continues to respond favourably to the generous cultivation and manuring. Other robusta plantations do not show the same promise, and although small portions of some plots are exceptionally good, large areas are poor.

Approximately 5 tons of clean coffee was harvested.

Aleurites montana.—The areas continue to show improvement.

Cinchona.—The *C. Ledgeriana* and *C.* hybrid plots continue to do well, although some losses have occurred in the earlier plantings of *C. Ledgeriana* from root disease (*Armillaria* sp.). A few trees of *C. succirubra* have made good growth, but the area under this species as a whole is poor.

Animals.—The keeping of animals at Amani and Kwamkoro is still a battle against the tsetse. Forty-six animals became infected with trypanosomiasis and although only nine of these died, the loss of condition to the animals and the work entailed in diagnosis and treatment presents a very difficult and expensive problem.

LIVESTOCK RETURN FOR 1940.

	Bulls and Bullocks	*Cows*	*Calves*	*Sheep*
No. at 1.1.1940	11	64	79	24
Receipts :—				
Births	—	—	44	19
Total	11	64	123	43
Issue :-				
Deaths	—	7	16	4
Sales	12	4	5	4
Total issue	12	11	21	8
Transfers	+11	+15	−26	—
Total 1.1.41	10	68	76	35
Causes of death				
Tryps	—	7	2	—
Starvation (mother dry) ...	—	—	5	1
Injury and accident ...	—	—	4	2
Abortion	—	—	2	1
?	—	—	3	—
Total deaths	—	7	16	4

F. M. ROGERS.
Superintendent of Plantations.

APPENDIX A.

Financial Statement for the year ended 31st December 1940*

Revenue.

	£	£
H.M. (Imperial) Treasury		6,000
Contribution, Tanganyika Territory		7,592
Contribution, Uganda		2,278
Contribution, Kenya		2,152
Contribution, Zanzibar		1,200
Contribution, Northern Rhodesia		300
Contribution, Nyasaland		300
		19,822
Local revenue recurrent	242	
Local revenue non-recurrent	318	
		560
		20,382

Maintenance Expenditure.

	£
Personal emoluments	11,858
Passages	348
Pensions contributions	2,307
Laboratories	655
Publications	148
Office, telephones and contingencies	195
Materials	616
Freight and transport	394
Travelling	650
Labour	1,575
	18,746

Capital Expenditure.

	£
Reconditioning water supply	100
New lorries	196
	296

Summary.

	£	£
Revenue	20,382	
Reserve on 31st December, 1939	4,755	
		25,137
Maintenance expenditure, 1940	18,746	
Capital expenditure, 1940	296	
		19,042
Gross reserve on 31st December, 1940		6,095
Capital expenditure authorized from reserve prior to 31st December, 1940, but not yet expended		704
		5,391

* A forecast. Final accounts not yet received from Accountant General, Dar es Salaam.

APPENDIX B.

Meteorological Records.

The rainfall at Amani in 1940 was above average but badly distributed. The "long rains" were heavy and the "short rains" for all practical purposes failed; more than half (5.3 in.) the rainfall recorded at Amani for October fell on one day. Kwamkoro rainfall was considerably above average but also badly distributed.

	Rainfall at Amani.			*Temperature at Amani.*				*Rainfall at Kwamkoro.*		
		1940.		*Mean monthly Maxima (°C).*		*Mean monthly Minima (°C).*			*1940.*	
	26-yr. av. ins.	*ins.*	*Rainy days.*	*11-yr. av.*	*1940.*	*11-yr. av.*	*1940.*	*11-yr. av. ins.*	*ins.*	*Rainy days.*
January	3.22	5.00	20	26.7	27.2	17.7	18.1	2.40	5.95	14
February	3.17	2.19	7	27.4	27.9	17.8	17.6	2.73	1.09	6
March	6.91	7.99	20	26.4	25.8	18.0	17.9	8.46	13.23	18
April	14.15	23.08	30	24.7	23.5	17.9	18.1	14.82	31.73	30
May	13.51	15.46	25	22.6	23.6	17.3	17.5	19.89	20.19	20
June	4.78	2.22	16	21.7	22.6	15.6	19.2	6.84	4.26	12
July	3.92	2.73	22	21.3	21.7	14.7	15.2	3.70	4.02	18
August	3.80	7.30	22	21.3	21.9	14.2	15.1	4.69	5.91	16
September	4.19	3.71	17	22.1	22.5	14.5	15.1	5.26	4.86	15
October	6.28	10.05	15	23.3	24.0	15.4	16.2	6.70	8.18	12
November	6.40	1.22	10	25.3	26.1	16.5	16.6	5.10	1.92	11
December...	6.70	2.71	19	25.9	27.4	17.6	17.6	5.76	3.80	11
	77.03	83.66	223	—	—	—	—	86.35	105.14	183

APPENDIX C.

List of Publications Distributed during 1940 by the East African Agricultural Research Station.

Memoirs.

72. Contributions to the ornithology of the East African islands. R. E. Moreau. *Ibis*, Ser. 14, Vol. 4, pp. 48–91, 1940.

73. Numerical data on African birds' behaviour at the nest, II. *Psalidoprocne holomelaena massaica* Neum. R. E. Moreau. *Ibis*, Ser. 14, Vol. 4, pp. 234–248, 1940.

74. A convenient method for the excavation of growing trees in undisturbed soil. F. A. F. Schmid and F. J. Nutman. *Soil Science*, Vol. 49, pp. 411–416, 1940.

Reprints and other Miscellaneous Publications.

Report on a journey to parts of the West Indies and the United States for the study of soils, February to August, 1938. G. Milne. Government Printer, Dar es Salaam.

Soil and vegetation. G. Milne. *E. Afr. Agr. J.*, Vol. 5 (4), pp. 294–298, 1940.

A Swahili-Botanical-English Dictionary of plant names. P. J. Greenway. Government Printer, Dar es Salaam.

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